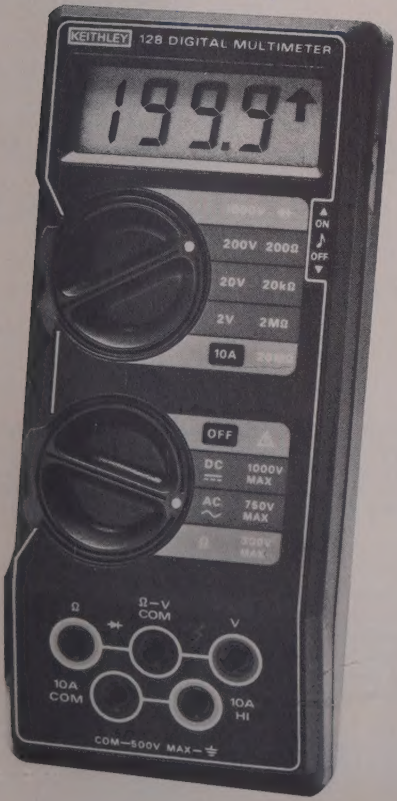
KEITHLEY

PA4282

Model 128
Digital Multimeter

Instruction Manual

10-6-81



Specifications

DC VOLTS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(% rdg + digits) 18°-28°C
2V	1mV	±(0.5% + 1d)
20V	10mV	
200V	100mV	
1000V	1 V	

MAXIMUM ALLOWABLE INPUT: 1000V DC or peak AC.
INPUT RESISTANCE: 10MΩ.
NORMAL MODE REJECTION RATIO: Greater than 46dB at 50Hz, 60Hz.
COMMON MODE REJECTION RATIO: Greater than 100dB at DC, 50Hz and 60Hz (1kΩ unbalance).

AC VOLTS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(% rdg + digits) 18°-28°C	FREQUENCY RANGE
2V	1mV	±(1% + 5d)	45Hz-500Hz
20V	10mV		45Hz-500Hz
200V	100mV		45Hz-500Hz
750V	1 V		45Hz-500Hz

MAXIMUM ALLOWABLE INPUT: 1000V peak.
INPUT IMPEDANCE: 10MΩ shunted by less than 100pF.
RESPONSE: Average responding, calibrated in rms of a sine wave.

OHMS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(% rdg + digits) 18°-28°C	FULL SCALE VOLTAGE
200 Ω	100mΩ	±(0.5% + 3d)	<0.3V
2 kΩ	1 Ω	±(0.5% + 1d)	<0.3V
2MΩ	1kΩ	±(0.5% + 1d)	<0.4V
20MΩ	10kΩ	±(2 % + 1d)	<0.4V

DIODE TEST: On-scale reading for 1 or 2 forward biased silicon diodes (@ 1mA).
MAXIMUM OPEN CIRCUIT VOLTAGE: 3.2V on diode test and 200Ω ranges; 0.8V on all other ranges.
MAXIMUM ALLOWABLE INPUT: 300V DC or rms.

DC AMPS

RANGE	RESOLUTION	ACCURACY (1 YEAR) ±(% rdg + digits) 18°-28°C	MAXIMUM FULL SCALE VOLTAGE BURDEN
10A	10mA	±(1.5% + 1d)	0.3V

MAXIMUM ALLOWABLE INPUT: 20A for 15 seconds (unfused).

AC AMPS

RANGE	RESOLUTION	ACCURACY (1 YEAR) 45Hz-500Hz 18°-28°C	MAXIMUM FULL SCALE VOLTAGE BURDEN
10A	10mA	±(2% + 5d)	0.3V rms

MAXIMUM ALLOWABLE INPUT: 20A for 15 seconds (unfused).

THRESHOLD DETECTOR

Display indicates above (↑) or below (↓) the set threshold on any range. An audio tone (switch enabled) sounds for voltage or current above the threshold or a resistance below the threshold. Threshold is adjustable for +0.5% to +15% of full scale on volts, amps and the 200Ω range.

GENERAL

DISPLAY: 3½-digit LCD, 15mm (0.6") height, with polarity and range indication.
OVERRANGE INDICATION: 3 least significant digits blanked.
MAXIMUM COMMON MODE VOLTAGE: 500V peak.
ENVIRONMENT: Operating: 0°-50°C, less than 80% relative humidity up to 35°C. **Storage:** −35° to 60°C.
TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C): Less than 0.1 × applicable accuracy specification/°C.
POWER: 9V alkaline or C-Zn battery (NEDA 1604).
BATTERY LIFE: 200 hours typical with C-Zn cells; 350 hours with alkaline cells.
BATTERY INDICATOR: Display indicates "BAT" when less than 10% of life remains.
DIMENSIONS, WEIGHT: 178mm long × 76mm wide × 38mm thick (7" × 3" × 1.5"). Net weight, 315gm (11 oz.).
ACCESSORIES SUPPLIED: Test leads, battery, operator's manual.
ACCESSORIES AVAILABLE:
Model 1301 Temperature Probe
Model 1304 Soft Carrying Case & Stand
Model 1306 Deluxe Carrying Case
Model 1600A High Voltage Probe
Model 1681 Clip-On Test Lead Set
Model 1682A RF Probe
Model 1683 Universal Test Lead Kit
Model 1685 Clamp-On Current Probe
Model 1691 General Purpose Test Leads

Prices and specifications subject to change without notice.

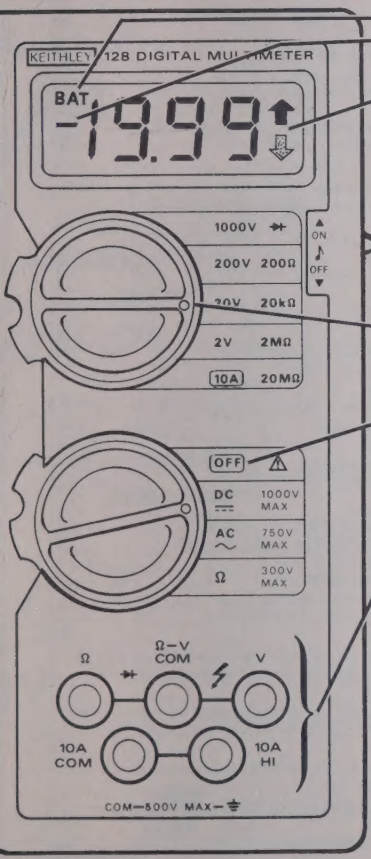
WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace, at our option, any instrument or part thereof, which within a year from date of shipment, proves defective upon examination. We will pay local domestic surface freight costs. (NOTE: This warranty does not cover battery replacement or damage due to battery leakage.

SERVICE POLICY

For service contact your local representative who will be able to give you immediate assistance in most cases. Complete repair and calibration facilities are maintained in Cleveland, Ohio; Munich, West Germany; and Reading, United Kingdom, as well as first line repair service in Palaiseau, France. Information concerning the application, operation or service of your instrument may be directed to the applications engineer at any of the locations specified.

Operating Instructions



Low Battery Indicator
Minus sign displayed
Plus sign implied
Threshold Indicator
Threshold Detector ON/OFF

1. ENABLE AUDIO TONE OF THRESHOLD DETECTOR, if desired.

2. SELECT RANGE

DCV - 2V, 20V, 200V, or 1000V
ACV - 2V, 20V, 200V or 1000V
NOTE: 750V AC is the maximum allowable AC input.
DCA - 10A
ACA - 10A
Ω - 200Ω, 20kΩ, 2MΩ, or 20MΩ

3. SET POWER ON BY SELECTING DESIRED FUNCTION

4. APPLY INPUT

Select the appropriate pair of input jacks. COM to V for all voltage measurements AC and DC.
COM to Ω for all resistance measurements.
10A COM to 10A HI for all current measurements.

5. MAKE THE MEASUREMENT

CAUTION

The maximum allowable input for:
DCV = 1000V DC or peak AC
ACV = 1000V peak or 750V rms
Ω = 300V DC or rms
DCA, ACA = 20A for 15 sec (unfused)

DIODE TEST RANGE

The diode range on the ohms function can be used for testing of semiconductor junctions. A junction is probably good if the 128 indicates an overrange reading when the semiconductor is reversed biased, and an on range reading, when the semiconductor is forward biased. The diode symbol between the Ω jack and Ω-V COM jack shows forward biased direction. The test current is approximately 1mA. Multiple junctions such as Darlingtons, LEDs, etc., can also be tested on this position.

For one forward biased junction the display will read approximately 600 counts. For two forward biased junctions the display will read approximately 1200 counts. For a forward biased LED the display will read approximately 1500 counts. If a forward biased junction reads approximately zero, then the diode is shorted.

Threshold Detector

The threshold detector capability is available on all Volts, Amps and Resistance ranges. It can also be disabled (muted) for the situations that do not require an audio tone for a detection level. The switch to disable the audio tone is located on the side of the 128.

The audio tone sounds for a voltage above the threshold or a resistance below the threshold. An arrow (threshold indicator) on the display indicates where the present reading is, above or below the threshold. The arrow points up for a reading above the threshold, and it points down for a reading below the threshold.

The following examples illustrate some of the applications where a threshold detector would be useful.

Logic Levels

The threshold detector can be utilized for sensing logic levels or other active signals. The detector level is set at the factory for 250 counts (2.5V) on the 20V range. This level is ideally suited for logic level testing on CMOS, TTL or other logic families. When the applied signal is greater than the detector level, an audio tone will sound, and an arrow pointing upward will be displayed. When the applied signal is less than the detector level, an arrow pointing downward is displayed and the audio tone will not sound.

Continuity

The threshold detector can be utilized for continuity testing. The factory set detector level is approximately 250 counts (25Ω) on the 200Ω range.

The continuity test is excellent for short circuit testing in large systems where hand-eye contact is necessary at all times. It is also convenient for checking point to point continuity of circuits. The threshold detector level is the same number of counts (250 counts factory set) on all Volts and Amps ranges. It is typically the same on the 200Ω range, but may vary on this range due to component tolerances. The set level varies from range to range on the Ohms function due to the ratiometric measurement technique.

When the detection level is set at 250 counts on Volts (factory setting), the detection level for the Ohms ranges are listed below.

Range	Approximate Counts	Approximate Resistance
200Ω	250	25.0 Ω
20kΩ	125	1.25kΩ
2MΩ	50	50kΩ
20MΩ	50	500kΩ

SAFETY PRECAUTIONS

1. Do not exceed the instrument's maximum allowable inputs as defined in the Specifications.
2. Do not apply more than 500V peak above earth ground to the COM input jack.
3. Exercise extreme caution when a shock hazard is present at its input. The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 volts rms or 42.4 volts peak are present.
4. A good safety practice is to expect that hazardous voltages are present in any unknown circuit to be measured until actual conditions are verified.
5. The battery is accessible from the bottom of the instrument. Note the precautions on the case before installing or replacing.

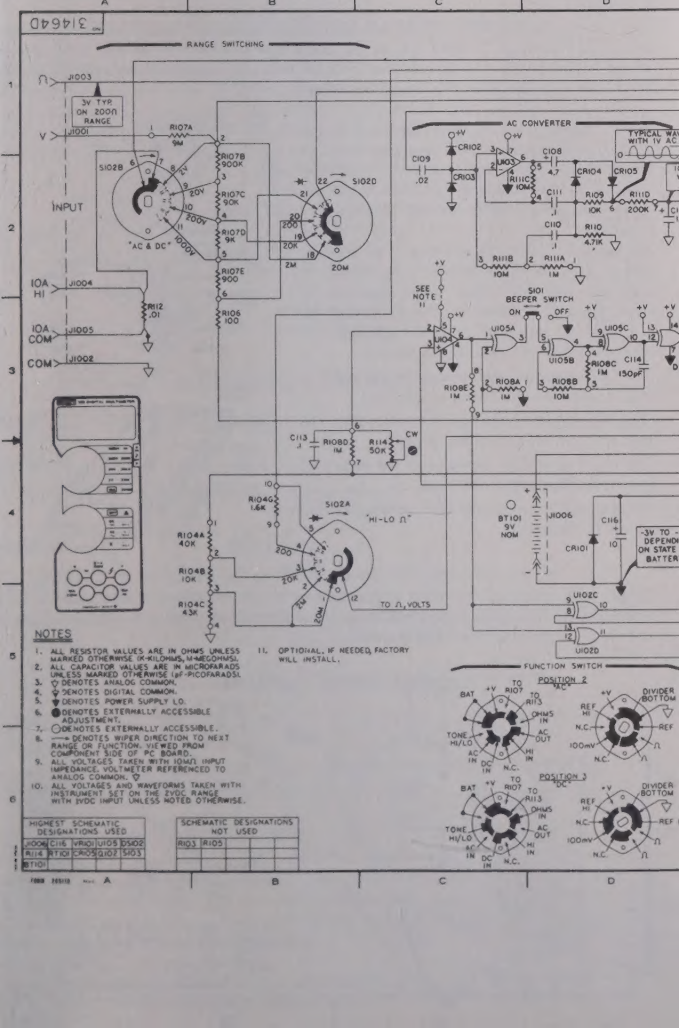
SAFETY SYMBOLS AND TERMS

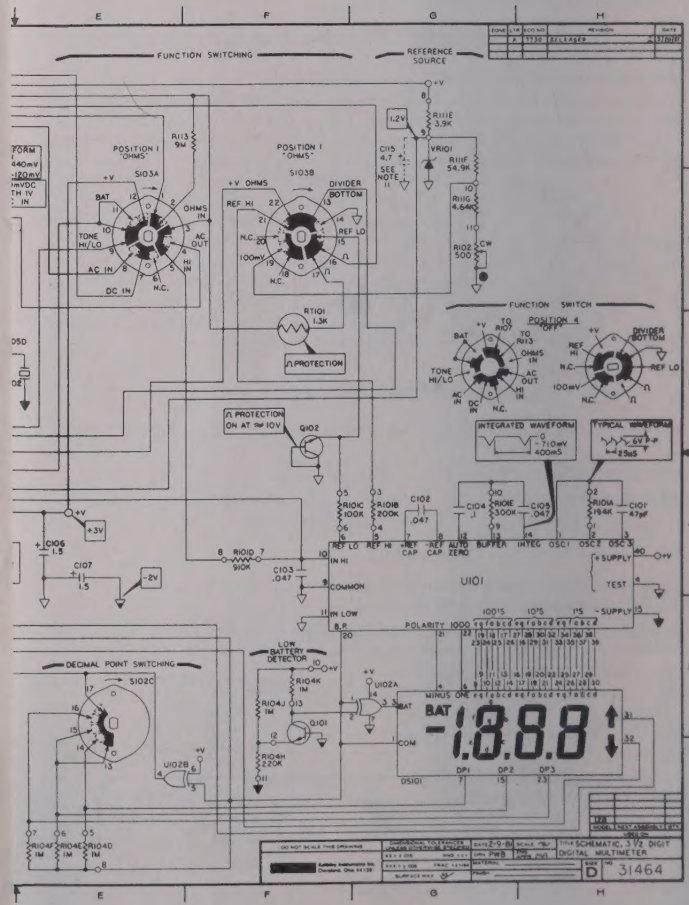
The symbol on the instrument denotes that the user should refer to the operating instructions.

The symbol on the instrument denotes that 1000V or more may be present on the terminal(s).

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.


3164D
RANGE SWITCHING
AC CONVERTER
FUNCTION SWITCH
INPUT
"AC & DC"
"HI-LO Ω"
TO Ω, VOLTS
SEE NOTE 11
S101 BEEPER SWITCH
ON
OFF
TYPICAL WAVEFORM WITH 1V AC
-3V TO DEPEND ON STATE BATTERY
POSITION 2
POSITION 3
DIVIDER BOTTOM
NOTES
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS MARKED OTHERWISE (K-KILOHMS, M-MEGOHMS).
2. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS MARKED OTHERWISE (pF-PICOFARADS).
3. ▽ DENOTES ANALOG COMMON.
4. ▽ DENOTES DIGITAL COMMON.
5. ▼ DENOTES POWER SUPPLY LO.
6. ● DENOTES EXTERNALLY ACCESSIBLE ADJUSTMENT.
7. ○ DENOTES EXTERNALLY ACCESSIBLE.
8. ——→ DENOTES WIPER DIRECTION TO NEXT RANGE OR FUNCTION VIEWED FROM COMPONENT SIDE OF PC BOARD.
9. ALL VOLTAGES TAKEN WITH 10MΩ INPUT IMPEDANCE, VOLTMETER REFERENCED TO ANALOG COMMON.
10. ALL VOLTAGES AND WAVEFORMS TAKEN WITH INSTRUMENT SET ON THE 5VDC RANGE WITH 5VDC INPUT UNLESS NOTED OTHERWISE.
11. OPTIONAL, IF NEEDED, FACTORY WILL INSTALL.
HIGHEST SCHEMATIC DESIGNATIONS USED
SCHEMATIC DESIGNATIONS NOT USED


FUNCTION SWITCHING
REFERENCE SOURCE
POSITION 1 "OHMS"
POSITION 1 "OHMS"
DIVIDER BOTTOM
FUNCTION SWITCH
POSITION 4 "OFF"
INTEGRATED WAVEFORM
TYPICAL WAVEFORM
PROTECTION ON AT ≥ 10V
DECIMAL POINT SWITCHING
LOW BATTERY DETECTOR
U101
DSI01
SCHEMATIC, 3½ DIGIT DIGITAL MULTIMETER
31464

Service Information

WARNING

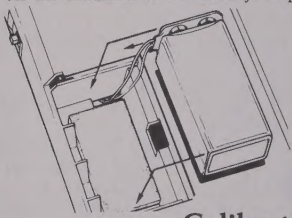
All service information is intended for qualified electronic maintenance personnel only.

Turn the 128 off and disconnect the input probes before replacing the battery. Put the cover back into place on the battery compartment before resuming use of the instrument.

Battery Installation/Replacement

(Refer to the above warning before replacing the battery).

A 9V battery is supplied with the instrument but not installed. To install or replace the battery, remove the cover from the battery compartment by sliding it off in the direction of the arrow located on the battery cover. The battery connector snaps on and off the terminals of the battery. Improper installation of the battery will cause the connecting wires to be severed by excess strain. Proper installation requires that the battery be positioned in such a manner (see drawing) that the leads protruding from the boot of the battery connector face toward the outside of the battery compartment. If the instrument is going to be stored for a long period of time or in a high temperature environment, remove the battery to prevent leakage damage.



Calibration Procedure

EQUIPMENT NEEDED: 4½ digit DVM with .05% accuracy or better and a 200mV range.

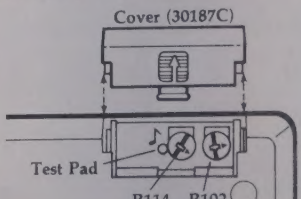
MODEL 128 SETTINGS: DCV function, 2V range.

ENVIRONMENTAL CONDITIONS: Ambient temperature of 23° ±3°C; relative humidity less than 80%.

WARNING

To prevent a shock hazard, all test leads should be removed from the INPUT terminals before removing any cover.

1. Remove the cover as shown in the Figure below to expose the Test Pad, Calibration Pot **R102** and Threshold Detector level Pot R114.
2. Set the 4½-digit DVM to the 200mV range. Connect the common lead of the DVM to the Ω-V COM input jack of the 128. Connect the HI lead of the DVM to the test pad.
3. Adjust **R102** of the Model 128 for a display of 100.00 ±5 digits (50μV) on the 4½-digit DVM.
4. Disconnect the test leads and replace the cover.



The threshold detector level is adjustable from +.5% to +15% of full scale on Volts, Amps and the 200Ω range. The threshold detector level is set at the factory for 250 counts of full scale of the voltage and current ranges. To adjust the set level to a different level use the following procedure:

A. Select function and range.
B. Apply input equal to that of desired detection level.
C. Adjust R114 until the threshold detector sounds.

Disassembly Instructions

Place the unit face down on a bench or other similar surface and remove the battery compartment cover. Disconnect and remove the battery. Remove the two # 4-40 X $^{7}/_{8}$ retaining screws.

Grasp the bottom cover at the input jack end and with a lifting and forward pushing motion (see drawing), carefully remove the bottom cover. While removing the cover, feed the battery connector through the access opening in the bottom of the battery compartment.

The component side of the PC board is now exposed and the battery can be reconnected for troubleshooting. To read the display, some light downward pressure at the top end of the circuit board may be required in order to make contact through the conductive elastomer strip, between the circuit board and the LCD.

The PC board and LCD assembly are not secured once the case retaining screws are removed. Be careful not to allow the PC board and LCD assembly to fall out or shift out of position during troubleshooting.

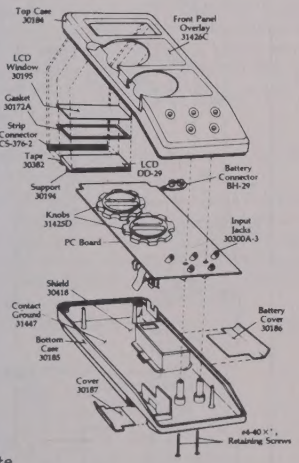
To remove the PC board from the top cover, grasp the function switch assembly and lift until the input jacks become disengaged from the cover. The PC board can now be removed using a clockwise motion to free the two switch knobs.

The LCD assembly will remain in the top cover when the PC board is removed.

The two switch knobs can be removed by pulling them off the switch shafts.

The LCD assembly, along with the strip connector lifts out of the case.

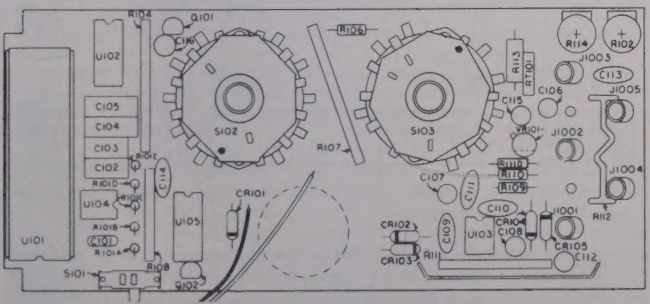
To reassemble the Model 128, reverse the above procedure.



Note

Proper alignment of the strip connector is necessary when reinstalling the LCD assembly. Make sure that the conductor side of the strip connector is positioned against the plastic support of the LCD assembly.

Component Layout



Parts List

Circuit Desig.	Description	Schematic Location	PC-Board Location	Keithley Part No.
BT101	Battery, 9V, NEDA 1604			BA-14
C101	Cap, 47pF, 500V, Mica	H4	3/B3	C-320-47pF
C102	Cap, .047μF, 100V, Poly	G4	4/B3	C-305-.047
C103	Cap, .047μF, 100V, Poly	F4	5/B3	C-305-.047
C104	Cap, .1μF, 100V, Poly	G4	6/B2	C-305-.1
C105	Cap, .047μF, 100V, Polyprop	G4	7/B2	C-306-.047
C106	Cap, 1.5μF, 25V, Alum	E4	8/E2	C-314-1.5
C107	Cap, 1.5μF, 25V, Alum	E4	9/D3	C-314-1.5
C108	Cap, 4.7μF, 25V, Alum	D2	10/D3	C-314-4.7
C109	Cap, .02μF, 500V, CerD	C2	11/D3	C-22-.02
C110	Cap, .1μF, 16V, CerD	D2	12/D3	C-238-.1
C111	Cap, .1μF, 16V, CerD	D2	13/D3	C-238-.1
C112	Cap, 1μF, 16V, Alum	D2	14/E3	C-325-1
C113	Cap, .1μF, 16V, CerD	B4	15/E2	C-238-.1
C114	Cap, 150pF, 1000V, CerD	D3	16/C3	C-64-150pF
C115	Optional Capacitor (see note 11 on schematic)			
C116	Cap, 10μF, 16V, Alum	D4	C2	C-313-10
CR101	Rectifier, 1A, 800V	D4	20/C3	RF-38
CR102	Rectifier, 75mA, 75V	C1	21/D3	RF-28
CR103	Rectifier, 75mA, 75V	C2	22/D3	RF-28
CR104	Rectifier, 75mA, 75V	D2	23/E3	RF-28
CR105	Rectifier, 75mA, 75V	D2	24/E3	RF-28
DS101	LCD, 3½ digit display	G4		DD-29
DS102	Beeper, Threshold Detector	D3	78/C4	EM-3
J1001	Jack, Input	A1	30/E3	30300A-3
J1002	Jack, Input	A2	31/E3	30300A-3
J1003	Jack, Input	A3	32/E2	30300A-3
J1004	Jack, Input	A3	33/E3	30300A-3
J1005	Jack, Input	A1	34/E2	30300A-3
J1006	Connector, Battery	D4	35/B4	BH-29
Q101	Transistor NPN	F5	38/C2	TG-47
Q102	Transistor NPN	F3	39/C3	TG-138
R101A	Resistor, 191K, 1%, ¹/₈W, Mtf.	H4	71/C3	R-88-191K
R101B	Resistor, 200K, 5%, ¹/₄W, Carb F	G4	72/C3	R76-200K
R101C	Resistor, 100K, 5%, ¹/₄W, Carb F	F4	73/C3	R-76-100K
R101D	Resistor, 910K, 5%, ¹/₄, Carb F	F4	74/C3	R-76-910K
R101E	Resistor, 274K, 1%, ¹/₈W, Mtf.	G4	75/C3	R-88-274K
R102	Pot, 500Ω	G2	42/E2	RP-119-500
R104	Thick Film Resistor	SEV	44/C2	TF-136
R106	Resistor, 100Ω, .1%, .1w, Mtf.	B3	46/D2	R-283-100
R107	Thick Film Reisistor	SEV	47/D3	TF-133
R108	Thick Film Resistor	SEV	48/C3	TF-138
R109	Resistor, 10kΩ, .1%, .1w, Mtf.	D2	49/D3	R-283-10k
R110	Resistor, 4.7kΩ, .1%, .1w, Mtf.	D2	50/D3	R-283-4.71k
R111	Thick Film Resistor	SEV	51/D3	TF-137
R111D	Resistor, 200K, 1%, ¹/₈W, Mtf.	D2	76/D3	R-88-200K
R112	Resistor, .01, .5%, 1w, WW	A3	52/E3	R-280-0.01
R113	Resistor, 9M, .7%, 1w, CerF	F1	53/D2	R-302-9M
R114	Pot, 50k	C4	54/E2	RP-119-50k
RT101	Thermistor, 8mA, 500V, PTC	F2	56/E2	RT-7
S101	Switch, SPDT, Threshold Detector	D2	58/C3	SW-417
S102	Switch, Rotary, Range	SEV	59/C2	SW-432
S103	Switch, Rotary, Function	SEV	60/D2	SW-431
U101	3½ digit A/D Converter	G4	63/B3	IC-296
U102	CMOS, Quad Exclusive OR Gate	SEV	64/B2	IC-226
U103	Low Power J-FET OP AMP	C2	65/D3	IC-227
U104	Monolithic CMOS OP AMP	C3	66/B3	IC-297
U105	CMOS, Quad Exclusive OR Gate	SEV	67/C3	IC-226
VR101	Diode, Low Voltage Reference		27/D3	DZ-62

Accessories

MODEL 1301 TEMPERATURE PROBE is a rugged low cost temperature probe designed to allow precision temperature measurements from -55°C to 150°C.

MODEL 1304 SOFT CARRYING CASE AND STAND for the Model 128.

MODEL 1306 DELUXE CASE is a rugged DMM carrying case that is large enough to accommodate the 128 plus various other DMM articles such as a spare battery, test leads, etc.

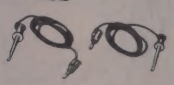
MODEL 1600A HIGH VOLTAGE PROBE extends the DMM to 40kV. It has a 1000:1 division ratio, which means that 1 volt on the DMM corresponds to 1 kilovolt.

TO OPERATE: Set the DMM to DCV and appropriate range. Connect the banana plug on the Model 1600A to the input jacks. Connect the alligator clip on the Model 1600A to source LO. Connect the probe tip to source HI.

SPECIFICATIONS

VOLTAGE RANGE: 0 to 40,000VDC
INPUT RESISTANCE: 1000MΩ
DIVISION RATIO: 1000:1

RATIO ACCURACY:
1000 to 1 ±2%
terminated in 10MΩ
2000 to 1 ±5%
terminated in 1MΩ



MODEL 1681 CLIP-ON TEST LEAD SET contains two leads, 1.2m (48 inches) long, terminated with banana plug and spring action clip-on probe.

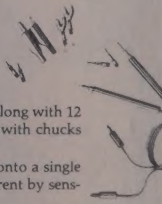
MODEL 1682A RF PROBE allows voltage measurments from 100kHz to 250MHz with the Model 128.

TO OPERATE: Set the DMM to DCV and appropriate range. Connect the Model 1682A to the DMM input jacks.

SPECIFICATIONS

AC to DC TRANSFER ACCURACY:
(23°C ±5°C): ±1dB from 100kHz to 250MHz at 1V, peak responding, calibrated in rms of a sine wave, compatible with instruments with 10MΩ input resistance
VOLTAGE RANGE: 0.25V to 15V rms
MAXIMUM ALLOWABLE INPUT:
50V AC peak, 200V (DC + AC peak)

MAXIMUM COMMON MODE VOLTAGE:
30V rms, 42 peak
INPUT CAPACITANCE: 5pF Typical
OPERATING TEMPERATURE: 0° to 50°C
CABLE LENGTH: 1.5 meters
ACCESSORIES SUPPLIED:
BNC Adapter, Insulating Tip, IC Tip, Spring Hook, Carrying Pouch



MODEL 1683 UNIVERSAL TEST LEAD KIT consists of two test leads 1.2m (48 inches) long with 12 screw-in-tips—2 banana plugs, 2 spade lugs, 2 alligator clips with boots, 2 needle tips with chucks and 4 heavy-duty tip plugs.

MODEL 1685 CLAMP-ON AC CURRENT PROBE measures AC current by clamping onto a single conductor. Interruption of the current path is unnecessary. The Model 1685 detects current by sensing magnetic field produced by current.

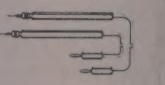
TO OPERATE: Set the DMM to ACV and appropriate range. Connect the Model 1685 to the DMM input jacks. The DMM will display 0.1V rms per ampere.

SPECIFICATIONS

RANGE: 2, 20, 200 amperes rms
ACCURACY: ±4% of range at 60Hz, ±6% of range at 50Hz
TEMPERATURE COEFFICIENT: ±0.05%/°C on the 20 and 200 ampere ranges—±0.3%/°C on the 2 ampere range

MAXIMUM ALLOWABLE CURRENT:
300 amperes rms
MAXIMUM CONDUCTOR VOLTAGE:
600 volts rms
CONVERSION RATIO:
0.1V rms per ampere

MODEL 1691 GENERAL PURPOSE TEST LEAD SET consists of two .91m (36 inches) test leads with probe tips terminated in banana plugs.



KEITHLEY

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